and cool the ballasts at the same time, which can lead to complex ultraviolet treatment systems.

Due to the variation between the sites and the possibly large number of lamps being deployed, the UV treatment systems can become very complex and consequently difficult to design, construct, and maintain. It is therefore advantageous to modularize the components of UV treatment systems for application to different sites and designs and to simplify the wiring of such systems.

The ability of an ultraviolet light treatment system to inactivate micro-organisms is a function of the UV fluence generated in the treatment system. The UV fluence is the product of the fluence rate and the time. The ability of ultraviolet light to penetrate wastewater, and hence treat the wastewater, is affected by the UV transmission. As the ultraviolet light emitted by the lamp decreases, the fluence rate also decreases. Thus, for a particular ultraviolet lamp, the important factors in the production of ultraviolet light include the age of the lamp, the degree of fouling of the lamps i.e. the degree of fouling of the quartz sleeve on the lamp, and the clarity of the wastewater that is being treated.

Steps may be taken to clean the lamps and especially the quartz sleeve on the lamp. These steps are typically carried out on a periodic basis using scrapers or other techniques.

The clarity of the water to be treated may be difficult or impossible to control. It is therefore advantageous to be able to control the power setting of the lamps to generate the level of UV required to inactivate the micro-organisms.

In addition, the amount of ultraviolet light obtainable from an ultraviolet lamp is limited. Thus, the consequence of the need to provide an UV fluence to efficiently and effectively treat the water is that there is a tendency and desire to place the ultraviolet lamps closer and closer together and/or to use more ultraviolet lamps. This tends to result in a headloss of water flowing through the treatment system. The cross-section of the ultraviolet lamps and their protective sleeves must be minimized in order to reduce the headloss.

Structural components of the rack of ultraviolet lamps are also a factor. If the ballast modules are placed under water in-line and next to the ultraviolet lamps on the rack, as is known, the ballast becomes a major limiting factor in the placement of the lamps closer together. It is therefore advantageous to reduce the size of the ballast as much as possible to reduce the headloss.

It is therefore an object of an aspect of the present invention for providing a UV treatment assembly having ease of adaptation to different water treatment sites, ease of construction and manufacture, and ease of maintenance.

Summary of the invention

According to an aspect of the present invention, there is provided a ballast module, for powering UV lamps in a fluid treatment assembly, that has an electronic ballast with a high resonance frequency. The high resonance frequency reduces the size of the components so that the ballast module can mounted in proximity with the UV lamps where the ballast module is also cooled by the fluid being treated by the UV lamps.

According to an aspect of the present invention, there is provided a ballast module. Each ballast module has all of the necessary components to control and to convert power line electrical energy into a form acceptable by at least one UV lamp, and to communicate with an assembly control unit to receive commands and to provide status information on the ballast module and UV lamps. The ballast modules are standardized for use in a number of UV water treatment assemblies of varying configurations.

For a particular water treatment site, a standardized ballast module may be used in all of the water treatment assemblies thereby simplifying manufacture and maintenance since there is only one part, versus a number of parts, to manufacture and to store in the spares inventory.

In one embodiment, where the ballast modules in the UV rack communicate over a single twisted-pair cable and receive power from a single power line from a control cabinet, construction of the water treatment assemblies are simplified as individual cables do not have to be laid from

each ballast module in a control cabinet to the UV lamps in the racks. In another embodiment, where the ballast modules have the capability to communicate over electrical power lines; the frames of the water treatment assemblies may have one common set of electrical conductors to all of the ballast modules for both communication and power purposes thereby further simplifying construction and maintenance.

In another embodiment, the ballast modules have electronic ballasts operating resonant circuits at frequencies in excess of 50 kHz, instead of the common 35 kHz, to drive the UV lamps. The advantages of operating at these frequencies include reducing the size of the inductor or transformer elements of a ballast sufficiently to allow ballast modules to be mounted in-line with standard elongate UV lamps with minimal headloss of water flow. Other advantages include capacitive isolation and improved power level adjustment for the UV lamps. Capacitors, instead of large transformers, are used to isolate the power lines from the power outlets to the UV lamps. The power level of the UV lamps is adjusted by varying the frequency of the resonant circuits: the further the frequency of the resonant circuits are operated away from resonance, the lower the amount of power is transferred to the UV lamps.

According to another aspect of the present invention, there is provided a fluid treatment assembly, comprising: a plurality of ultraviolet lamps adapted to be immersed in a fluid when the assembly is in use; a plurality of ballast modules for powering said ultraviolet lamps, each of said ballast modules having a ballast electrically connected to at least one ultraviolet lamp for powering said at least one ultraviolet lamp, the ballast having a resonant circuit with a resonance frequency for generating an alternating voltage source to power said at least one ultraviolet lamp and a driver circuit with a pulse frequency for supplying the resonant circuit with pulses of electrical energy; a frame member having a portion adapted to be immersed in the fluid when the assembly is in use, the frame member supporting said ultraviolet lamps and said ballast modules; and an electrical system for receiving electrical energy, which has a voltage and a current, and providing such to